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THE STRUCTURE AND ONTOGENY OF THE CHLORENCHYMA IN THE STEMS OF *ELEGIA* L. (RESTIONACEAE)*

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Abstract

The leaves (leaf sheaths) of the thirty-seven *Elegia* species studied are sessile, much reduced, often deciduous and in most cases without chlorenchyma.

In the stems however, a chlorenchymatous tissue is found on the inner side of a multiseriate epidermis.

The chlorenchyma consists of two types of cells namely protective cells and peg cells. These cells differentiate from the outer part of the ground meristem.

Uittreksel

DIE STRUKTUUR EN ONTOGENIE VAN DIE CHLORENCHIEM IN DIE STINGELS VAN *ELEGIA* L. (RESTIONACEAE)

Die blare (blaarskedes) van die sewe en dertig *Elegia*-spesies wat bestudeer is, is sittend, baie gereduseerd, dikwels afvallend en gewoonlik sonder enige chlorenchiem.

In die stingels kom daar egter 'n goed ontwikkelde chlorenchiemweefsel aan die binnekant van 'n meerlagige epidermis voor.

Die chlorenchiem bestaan uit twee seltipes nl. voeringselle (protective cells) en balkselle (peg cells). Hierdie selle differensieer uit die buitenste gedeelte van die grondmeristeem.

Introduction

Elegia L. (Restionaceae) is a xerophytic, perennial, dioecious, herbaceous monocotyledonous genus. It is endemic to South Africa and its natural occurrence is restricted to the southern and south-western parts of the Cape Province.

The orthotropic, aerial stems of the different species vary in length from 200 mm to 2 m. The stems of some species are branched while in others they are unbranched. In two species the branches are arranged in whorls.

The leaves are sessile and with exception of the bracts in the inflorescence, often deciduous. Although the leaf colour of a species is fairly constant, it varies from dark brown to yellow in different species. These anomalous leaf colours are due to the poor development (or absence) of chlorenchymatous tissue.

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MATERIAL AND METHODS

The anatomy of the median parts of the stem internodes of thirty-seven different species was comparatively studied. For ontogenetic studies, apical and intercalary meristems of young stems of *E. vaginulata* Mast. were used.

Collected fresh material was immediately fixed in F.A.A. (formalin-acetic acid-alcohol), dehydrated with TBA (tertiary butanol) and embedded in "Tissue-Mat" wax. Sections of apical and intercalary meristems were cut at 8 μm. All other sections were cut at 10 μm. All sections for light microscopic work were stained with haematoxylin/safranin (Johansen, 1940). Unstained sections for the scanning electron microscope were mounted on part of a microscope glass cover slip and vacuum coated with gold/palladium.

RESULTS AND DISCUSSION

The two to three layered chlorenchyma is located directly under the epidermis and consists of two different cell types viz. protective and peg cells (Cutler, 1969) (Fig. 1).

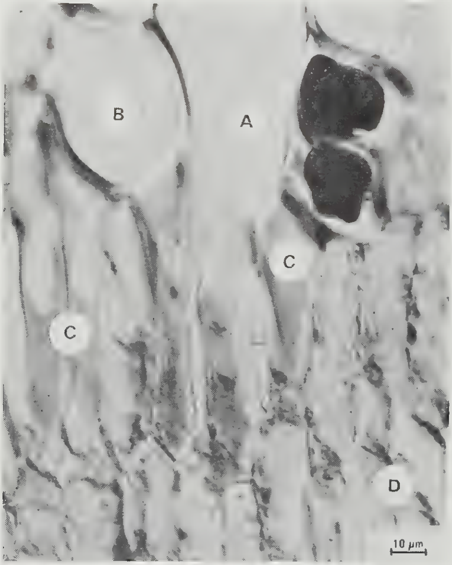

FIG. 1.
Cross-section through the epidermis and chlorenchyma in the stem of *E. vaginulata* Mast. A, substomatal chamber; B, epidermis cell; C, protective cells; D, peg cells.

Peg Cells

The outer two layers of the parenchyma, containing numerous chloroplasts, consist of radially elongated cells all of approximately the same length. The cells of the third layer vary from irregular to spherical in shape. Very few chloroplasts are visible in these cells. Nuclei are clearly visible.

Intercellular spaces occur between the radial, transversal and slanting tangential walls of the adjacent cells.

Numerous pegs (Fig. 2) connect adjacent peg cells with one another. Peg cells are also connected with protective cells by means of these pegs.

Scanning electron micrographs show no pits or pores associated with the peg connections between the peg cells (Fig. 2).

Although pegs are typical of the abovementioned cell walls they were not observed on any of the tangential walls between epidermis and chlorenchyma, nor could they be found between the chlorenchyma and the parenchyma sheath to the inner side of the chlorenchyma.

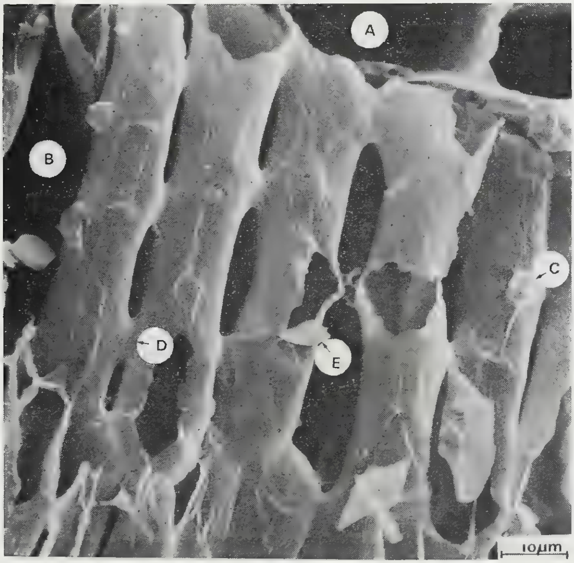

FIG. 2.

Scanning electron micrograph of peg cells and epidermis in the stem of *E. vaginulata* Mast. A, epidermis; B, intercellular space; C, vertical view of peg; D, peg as seen from the side; E, ruptured cell wall of peg cell.

Protective Cells

The use of the term protective cells (Cutler, 1969) is based on the assumption that these cells have a protective function since the walls lining the substomatal chamber have a thin cuticle.

Athough this name is accepted by the authors, it must be stressed that no experimental data exist to confirm this hypothesis. Protective cells are apparently always associated with stomata. Together with cells of the inner epidermis, they form a lining for the substomatal chamber. In median transections of the stomata, protective cells on opposite sides of the substomatal chamber are attached to each other at their bases only.

Protective cells are radially elongated with lignified cell walls and are usually longer than the peg cells, reaching up to half way or even further down into the second peg cell layer. No chloroplasts or nuclei were observed in these cells.

Ontogeny

Although the histogens—protoderm, ground meristem and procambium—differentiate from the intercalary meristem at the base of the second internode, the differentiation of the various tissues only commences in the fifth internode.

The chlorenchyma is the first tissue to differentiate from the ground meristem and occurs at the outer side of the ground meristem directly underneath the protoderm/epidermis.

At this stage the cells of the chlorenchyma are arranged in two layers and are polygonal and approximately uniform in size. The cell contents stain intensely. Intercellular spaces do not occur yet. No distinction can be made between the precursors of the peg cells and protective cells (Fig. 3).

Chloroplasts can easily be observed in these cells.

During growth and development of the stem, the outer circumference of the chlorenchyma increased with 45%.

The total width of the stretched individual cells however, accounts only for 34% of this increase in circumference. This is due to the fact that radial cell elongation exceeds tangential cell elongation, (compare Figs. 3, 4 and 5). The remaining 11% increase of the circumference is due to newly formed intercellular spaces and substomatal chambers.

As a result of incomplete schizogeny, these intercellular spaces do not occur over the whole length of the radial cell walls. The areas where intercellular spaces are not formed, and where the adjacent cell walls adhere locally to one another, constitute the pegs which are visible at a later stage of development. The protective cells have a greater radial elongation rate than the peg cells and differentiate later than the peg cells together with the substomatal chambers (compare Figs. 3 and 4).

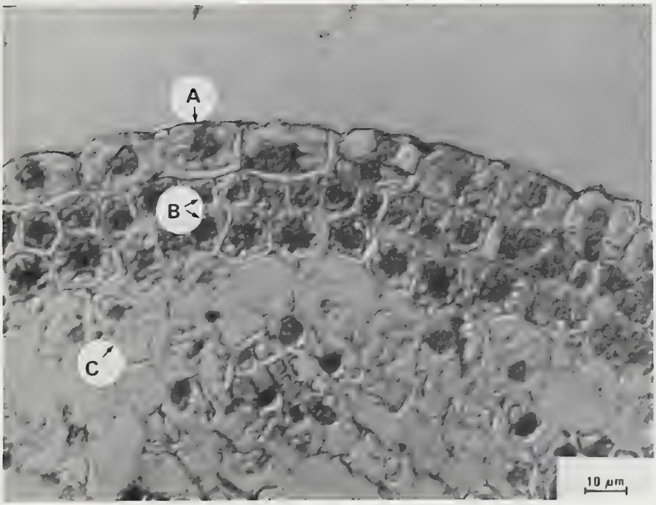

FIG. 3.

Embryonic tissues in the stem of *E. vaginulata* Mast. A, protoderm; B, chlorenchyma; C, parenchyma sheath.

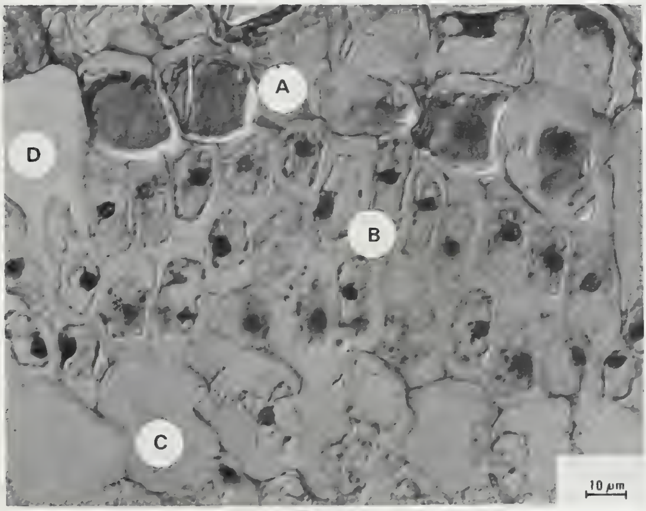

FIG. 4.

Immature tissues in the stem of *E. vaginulata* Mast. A, epidermis; B, chlorenchyma; C, parenchyma sheath; D, substomatal chamber.

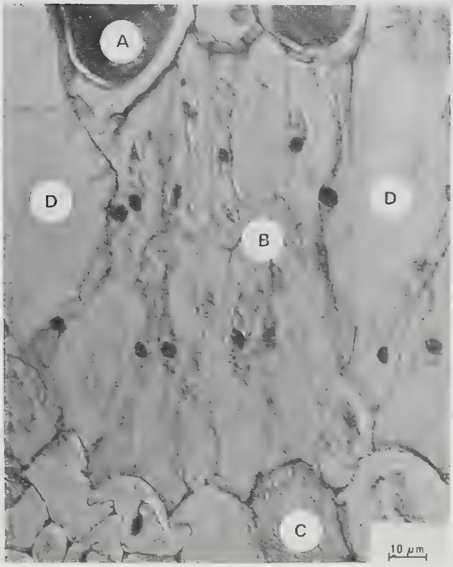

Fig. 5.

Immature tissues in the stem of *E. vaginulata* Mast. at a later stage of development than in fig. 4. A, epidermis; B, chlorenchyma; C, parenchyma sheath; D, substomatal chamber.

Conclusion

The chlorenchyma in the stem of *Elegia* L. is a specialized tissue with characteristic structure. This ontogenetic study revealed the origin of this highly modified parenchyma tissue and its differentiation into peg cells and protective cells.

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